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COMPLETE SPECIFICATION

Improvements in or relating to Electrical Signal Translating Circuits

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and ROY FRANK PRIVETT, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to electrical signal translating circuits.

It is frequently required to provide electrical signal translating circuits having a desired frequency/amplitude response over a given frequency range. For this purpose it is known to use an additional circuit in cascade with an electrical signal translating circuit having a frequency/amplitude response of other than the desired form in order to bring the overall frequency/amplitude response of the two circuits in cascade to the desired form.

One example of the use of such an additional circuit is as a so-called "equaliser" circuit connected in cascade with an amplifying circuit which has a non-uniform frequency/amplitude response over its working frequency range that is to say its pass-band. The "equaliser" circuit is then designed to have a frequency/amplitude response which will counteract this non-uniformity so that the overall characteristic of the two circuits connected in cascade will be substantially uniform over the working frequency range.

Where electrical signal translating circuits contain coupled resonant circuits or a pair of resonant circuits connected in different stages of the circuit tuned to a common frequency, the frequency/amplitude response over the working frequency range instead of being substantially uniform over this range and falling away at lower and higher frequencies may instead be too peaked, that is, it may fall away at lower and higher frequencies within the working range. Alternatively the characteristic may take the well known "double-humped" form. It is one object of the present invention to provide an electrical signal translating circuit which when connected in cascade with a circuit having one of these particular forms of non-uniform frequency/amplitude response, may be adjusted to render the overall frequency/amplitude response of the two circuits in cascade more nearly uniform over the working frequency range.

According to the present invention an electrical signal translating circuit comprises an impedance network, high impedance means for passing signal currents into said network and a high impedance load connected across at least part of said network, said impedance network constituting the only signal translating path in either direction coupling said high impedance means and said load and comprising a parallel resonant circuit, resonant at a predetermined frequency, and a series resonant damping circuit, resonant substantially at said predetermined frequency, which is connected across a part at least of said parallel resonant circuit, the arrangement being such that the effective value of the inductive and capacitive components of the parallel resonant circuits or of the resistive component of impedance of the series resonant damping circuit may be varied to modify to various peaked and/or double humped forms the frequency/amplitude response of the impedance network to signal

currents passed into it in operation.

According to a feature of the present invention an electrical signal translating circuit comprises a first thermionic valve amplifying stage, having a first parallel resonant circuit, resonant at a predetermined frequency, connected in the anode circuit thereof, which first resonant circuit is electrically connected to a second parallel resonant circuit, resonant substantially at said predetermined frequency and connected in the input circuit of a second thermionic valve amplifying stage, and a series resonant damping circuit, resonant substantially at said predetermined frequency, which is connected across part at least of one of the parallel resonant circuits, the arrangement being such that the effective value of the inductive and capacitive components of one or both of the parallel resonant circuits or of the resistive component of impedance of the series resonant damping circuit may be varied to modify to various peaked and/or double humped forms the frequency/amplitude response of the electrical signal translating circuit to signals applied in operation to the input of said first stage.

The effective value of the inductive and capacitive components of a parallel resonant circuit may be varied by selectively connecting one or more further parallel resonant circuits, also resonant substantially at said predetermined frequency, in parallel with the one parallel resonant circuit.

The effective value of the resistive component of impedance of the series resonant damping circuit may be varied by selectively connecting one or more resistors in series with the series resonant damping circuit. Alternatively where the series resonant damping circuit includes a resistor, the said resistive component of impedance may be varied by selectively connecting one or more resistors in parallel with or into circuit in place of the said resistor, or the series resonant damping circuit may include a variable resistor.

When circuits in accordance with the invention are adapted for use as equaliser circuits in cascade with an amplifier circuit, the said predetermined frequency may be the mid-frequency of the pass band of the amplifier circuit.

Four arrangements of electrical signal translating circuits in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawings in which,

Figures 1 and 3 show circuit diagrams of simple basic circuits;

Figures 2 and 4 illustrate the variation in the frequency/amplitude response curves of the circuits of Figures 1 and 3 respectively; and

Figures 5 and 6 show circuit diagrams of "equaliser" circuits for use in conjunction with wide-band high-frequency amplifying circuits.

Referring now to Figure 1 of the accompanying drawings, the circuit comprises a parallel resonant circuit 1 across which is connected a series resonant damping circuit 2 both resonant circuits 1 and 2 being tuned to substantially the same frequency. The circuit is connected between a pair of input terminals 3 and a pair of output terminals 4. The parallel resonant circuit 1 comprises an inductance 5 connected in parallel with a capacitance 6 The series resonant damping circuit 2 comprises an inductance 7, a capacitance 8 and a resistor 9, all connected in series. Additional resistors 10 and 11 may be selectively connected in parallel with the resistor 9 by means of the independent switches 12 and 13, there being four possible combinations of the resistors 9, 10 and 11 which may thereby be connected in series with the inductance 7 and the capacitance 8. With the values of the resistors suitably chosen, the circuit may give four frequency/amplitude response curves of the kind shown approximately in Figure 2 of the accompanying drawings. Only a short part of each response curve is shown, in each case, in the neighbourhood of the frequency to which the resonant circuits 1 and 2 are tuned, which frequency is indicated by *fo* on the frequency axis of the graphs. As the resistance in the series resonant circuit 2 is increased, the response curve passes successively in order through curves of the kind shown at 14—17 in Figure 2. The curve 14 is of the "double-humped" type, curve 15 is almost flat, but slightly "double-humped," curve 16 is slightly peaked and curve 17 is rather more peaked.

If the circuit of Figure 1 is connected in cascade with another circuit, for instance an I.F. amplifier of which the frequency/amplitude response may become non-uniform over the designed pass-band, either by becoming "double-humped" or too peaked, the overall response of the two circuits in cascade, the resonant frequencies of the resonant circuits 1 and 2 being made substantially the same as the mid-frequency of the amplifier pass-band, may be made substantially uniform over the desired band of frequencies by adjusting the value of the total resistance in the series resonant damping circuit 2. Thus where the I.F.

amplifier has a pronounced "double-humped" characteristic, the circuit of Figure 1 would be adjusted to have a characteristic similar to the curve 17 in Figure 2, and so on.

The circuit of Figure 1 has one disadvantage in that the total resistive component of the impedance of the circuit may vary substantially as the resistors 10 and 11 are switched in and out of the circuit. This has the effect of causing the amplitude of the response at frequency *fo* for constant input to vary, as shown in Figure 2. This may be undesirable in circuits where it is required to maintain a constant signal level.

This disadvantage may be remedied by using a circuit as shown in Figure 2 of the accompanying drawings. In this circuit, a parallel resonant circuit 1 comprising an inductance 5 and capacitance 6, and a series resonant damping circuit 2 comprising an inductance 7, capacitance 8 and resistor 9, are connected in parallel across a pair of input terminals 3 and output terminals 4. The resonant circuits 1 and 2 are resonant at substantially the same frequency. Additional parallel resonant circuits 18, each comprising an inductance 19 and a capacitance 20 and each resonant at substantially the same frequency as the resonant circuits 1 and 2, may be selectively connected in parallel with the resonant circuits 1 and 2 by means of two independent switches 21. The effect of switching in the additional parallel resonant circuits 18, is in effect to vary the value of the capacitive and inductive components of the parallel resonant circuit 1, whilst maintaining the resonant frequency constant. Thus the Q and hence the shape of the resonance curve of the effective parallel resonant circuit formed by combinations of the parallel resonant circuit 1 with none, one or two of the parallel resonant circuits 18 connected in parallel may be varied by switching the circuits 18 in and out of the circuit.

In this way the frequency/amplitude response of the circuit of Figure 2 may be varied as shown approximately in Figure 4 of the accompanying drawings. Only a short part of the response curve is shown, in each case, in the neighbourhood of the frequency *fo* to which the resonant circuits 1, 2 and 18 are tuned. As in the case of the circuit of Figure 1 when the value of the resistance is increased, the response curve passes successively through curves of the kind shown at 22—25 in Figure 4. However in this case since the total resistive component of impedance of the circuit remains almost constant, the amplitude of the response at frequency *fo* is substantially constant for constant input.

As in the case of the circuit of Figure 1, the circuit of Figure 3 may be connected in cascade with another circuit, for instance an I.F. amplifier of which the amplitude/frequency response may be non-uniform over the designed pass-band either by becoming "double-humped" or too peaked, to render the overall frequency/amplitude response substantially constant. The resonant frequencies of the resonant circuits 1, 2 and 14 are made substantially equal to the mid-frequency of the I.F. amplifier pass-band and the values of the capacitive and inductive components of the effective parallel resonant circuit are adjusted until the overall response of the two circuits is of the desired form.

The circuits of Figures 1 and 3 of the accompanying drawings are of basic design and a practical application of each is shown in Figures 5 and 6 respectively. The circuits of Figures 5 and 6 are "equaliser" circuits designed to be used in cascade with wide-band high-frequency amplifiers which form the I.F. amplifiers of the final receivers at each terminal of a television relay system. Both these I.F. amplifiers and I.F. amplifiers provided at the relay stations of the system are of the kind which include pairs of resonant circuits tuned to a common frequency, and more particularly are of the kind described in the Complete Specification of our co-pending Patent Application No. 30945/48 (Serial No. 655,833). In order that the overall bandwidth of all the I.F. amplifiers in the relay system, which includes three relay stations, may be 9 Mcs. each of the I.F. amplifiers is designed to have a flat-topped pass-band of 15 Mcs. about the intermediate frequency of 34 Mcs. In practice, however, due to one or more of the resonant circuits becoming misaligned, the frequency/amplitude response curve may become "double-humped" or too peaked instead of being of the desired flat-topped form. The equaliser circuits connected in cascade with the I.F. amplifiers are provided so that by a simple adjustment of them, the overall frequency/amplitude response of the amplifier and equaliser circuits may be made more nearly of the desired form.

The equaliser circuit shown in Figure 5, includes two high frequency pentode valves 26 and 27. The cathode heater of each valve 26 and 27 is connected to a suitable electric supply, whilst the cathodes are connected to earth through biassing resistors 28 each shunted by a high-frequency by-pass capacitor 29 in

the normal manner. The suppressor grids of the valves 26 and 27 are connected to the cathodes. The screen grids of the valves 26 and 27 are connected to the terminal 30 through resistors 31, decoupling capacitors 32 being connected between the screen grids and earth. The positive terminal of a high-tension direct-current supply (not shown in the drawings) is connected to the terminal 30, and the negative terminal is connected to earth.

The parallel resonant circuit 1 of the circuit of Figure 1 is split in this circuit into two parallel parallel resonant circuits *1a* and *1b*, formed by the inductances *5a* and *5b* and the capacitances *6a* and *6b* respectively. The capacitance *6a* is formed by the interelectrode capacities of the valve 26 and by any other stray capacity effectively in parallel with inductance *5a*. The capacitance *6b* is formed by the grid-cathode capacity of the valve 27 and any stray capacities in parallel therewith. The values of the inductances *5a* and *5b* are chosen so that they resonate with the capacitances *6a* and *6b* respectively at a frequency of 34 Mcs., which is the mid-frequency of the I.F. amplifier pass-band.

The parallel resonant circuit *1a* is connected between the anode of the valve 26 and through a high frequency decoupling circuit comprising a resistor 33 and capacitance 34, to the terminal 30 which is connected to the positive terminal of the H.T. supply. The parallel resonant circuit *1b* is connected between the grid of the valve 27 and earth and is also connected to the anode of the valve 26 by a direct-current blocking condenser 35, which has virtually zero impedance at high-frequencies.

The series resonant damping circuit 2, comprising the inductance 7, capacitance 8 and resistor 9, and resonant at a frequency of 34 Mcs., is connected between the anode of the valve 26 and earth. Additional resistors 10 and 11 may be selectively connected in parallel with the resistor 9 by means of independent switches 12 and 13. The output of the I.F. amplifier is connected across the terminals 3 and the output of the equaliser circuit is taken from across the terminals 4.

As in the case of the circuit of Figure 1 the frequency/amplitude response of the equaliser circuit may be adjusted by switching either one or both of the additional resistors 10 and 11 into circuit in parallel with the resistor 9. By suitably choosing the values of the resistors the response may be adjusted successively from a " double-humped " form, through a substantially flat form, to a peaked form. In operation the particular resistance is chosen which renders the combined response of the equaliser circuit in cascade with the I.F. amplifier most nearly flat over the pass-band required. If greater sensitivity of adjustment is required further resistors may be included in parallel with the resistors 10 and 11 to be switched in or out of circuit by further independent switches. Alternatively a potentiometer may be connected in parallel with the resistor 9.

In accordance with the considerations of reducing high frequency circuits passing through the chassis on which the circuit is made up, it is desirable that the various leads to earth from the circuit of each valve 26 and 27 be connected to a common point on the chassis. It is for this reason also that the two parallel resonant circuits *1a* and *1b* are provided. One inductance could be provided in the anode circuit of valve 26 of a value sufficient to resonate at a frequency of 34 Mcs. with the total capacity formed by the interelectrode capacities of the valve 26, the grid-cathode capacity of the valve 27 and stray capacities. The arrangement however would involve H.F. currents flowing through the chassis between the valves 26 and 27 and the arrangement described above with two inductances is preferred for that reason.

The equaliser circuit of Figure 5 suffers like the circuit of Figure 1 from the possible disadvantage that the gain at the mid-frequency of the pass-band varies as the total resistive impedance of the series resonant circuit 2 is varied, in a similar manner to that shown by the curves of Figure 2.

In the equaliser circuit of Figure 6 the disadvantage of variable gain is overcome by an arrangement corresponding to that of the circuit of Figure 3. The circuit is the same as that of Figure 5 except that there are no additional resistors to be switched into circuit in parallel with the resistor 9 of the series resonant damping circuit 2, and two additional parallel resonant circuits 18, each resonant at a frequency of 34 Mcs. and comprising an inductance 19 and a capacitance 20, may be selectively connected in parallel with the parallel resonant circuit *1b* by means of independent switches 21. As in the case of the circuit of Figure 3 the frequency/amplitude response of the equaliser circuit may be adjusted by switching either one or both of the additional parallel resonant circuits 18 into circuit in parallel with the parallel resonant circuits *1a* and *1b*. By suitably choosing the values of the inductive and

capacitive components of the additional parallel resonant circuits 18, the response may be adjusted successively, from a "double-humped" form, through a substantially flat form, to a peaked form. In operation the particular combination of parallel resonant circuits 18 with the parallel resonant circuit 1*b* is used which renders the combined response of the equaliser circuit in cascade with the I.F. amplifier most nearly flat over the pass-band required. If greater sensitivity of adjustment is required further additional parallel resonant circuits may be added to the circuit to be switched in parallel with circuit 1*b* as required.

As in the case of the circuit of Figure 5, it is desirable with a view to reducing the H.F. currents in the chassis of the made up circuit, that the various leads to earth from the circuit of each valve 26 and 27 should be connected to a common point on the chassis. In this case there is no appreciable alteration in the gain of the equaliser circuit as the additional tuned circuits are switched in and out of circuit, since the total resistive impedance of the circuit remains substantially constant during the switching.

In both the circuits of Figure 5 and Figure 6, the series resonant circuit 2 may be equally well connected between the grid of the valve 27 and earth, provided that where chassis currents are important the earth connection is returned to the common earth connection of the valve 26.

It is to be understood that circuits according to the present invention are only adapted for reducing non-uniformity in the frequency/amplitude characteristic of the "peaked" or "double-humped" form. They are not adapted to correct "tilt" in the characteristic, that is when the amplitude increases or decreases linearly with frequency over the desired handwidth, for which purpose a circuit according to the invention described in the Complete Specification of our co-pending Patent Application No. 10628/49 may be used. The equaliser circuit may, of course, be both in accordance with the present invention and in accordance with the invention described in the aforesaid application, in which case the equaliser circuit will preferably be of the kind described with reference to Figure 2 or Figure 6 of the accompanying drawings.

Where the equaliser circuit and the amplifier circuit are of a similar nature, for example where they both utilize coupled circuits of a similar type, the equaliser circuit will also serve to correct any variations in the phase/frequency characteristic of the amplifier which may arise due to the amplifier circuits becoming misaligned.

It will be appreciated that the invention is not limited to use with intermediate frequency amplifiers nor to radio equipment, but may be used for example in line telecommunications equipment, Moreover, although in the arrangements described above the circuit according to the invention has been separate from the apparatus whose characteristic it is adapted to modify, the circuit may form an integral part of such apparatus. Thus it may be one of the stages, and not necessarily the last stage, of an amplifier.

What we claim is:—

1. An electrical signal translating circuit comprising an impedance network, high impedance means for passing signal currents into said network and a high impedance load connected across at least part of said network, said impedance network constituting the only signal translating path in either direction coupling said high impedance means and said load and comprising a parallel resonant circuit, resonant at a predetermined frequency, and a series resonant damping circuit, resonant substantially at said predetermined frequency which is connected across a part at least of said parallel resonant circuit, the arrangement being such that the effective value of the inductive and capacitive components of the parallel resonant circuit or of the resistive component of impedance of the series resonant damping circuit may be varied to modify to various peaked and/or double humped forms the frequency/amplitude response of the impedance network to signal currents passed into it in operation.

2. An electrical signal translating circuit comprising a first thermionic valve amplifying stage, having a first parallel resonant circuit, resonant at a predetermined frequency, connected in the anode circuit thereof, which first parallel resonant circuit is electrically connected to a second parallel resonant circuit, resonant substantially at said predetermined frequency and connected in the input circuit of a second thermionic valve amplifying stage, and a series resonant damping circuit, resonant substantially at said predetermined frequency, which is connected across a part at least of the parallel resonant circuits, the arrangement being such that the effective value of the inductive and capacitive components of one or both of the parallel resonant circuits or of the resistive component of impedance of the series resonant damping circuit may be varied to modify to various peaked and/or

double humped forms the frequency/amplitude response of the electrical signal translating circuit to signals applied in operation to the input of said first stage.

3. An electrical signal translating circuit according to Claim 1 in which the capacitive component of the parallel resonant circuit is formed in part at least by the interelectrode capacities of a thermionic valve.

4. An electrical signal translating circuit according to Claim 2 in which the capacitive component of the first parallel resonant circuit is formed in part at least by the interelectrode capacities of the thermionic valve in the said first stage and the capacitive component of the second parallel resonant circuit is formed in part at least by the grid-cathode capacity of the thermionic valve in the said second stage.

5. An electrical signal translating circuit according to Claim 1 or Claim 3 in which the effective value of the inductive and capacitive components of the parallel resonant circuit may be varied by selectively connecting one or more further parallel resonant circuits, also resonant substantially at said predetermined frequency, in parallel with the parallel resonant circuit.

6. An electrical signal translating circuit according to Claim 2 or Claim 4 in which the effective value of the inductive and capacitive components of the parallel resonant circuits may be varied by selectively connecting one or more further parallel resonant circuits, also resonant substantially at said predetermined frequency in parallel with the first-mentioned parallel resonant circuits.

7. An electrical signal translating circuit according to any one of Claims 1—4 in which the effective value of the resistive component of impedance of the series resonant damping circuit may be varied by selectively connecting one or more resistors in series with the series resonant damping circuit.

8. An electrical signal translating circuit according to any one of Claims 1—4, in which the series resonant damping circuit includes a resistor, the said resistive component of impedance being varied by selectively connecting one or more resistors in parallel with or in place of the said resistor.

9. An electrical signal translating circuit according to any one of Claims 1—4 in which the series resonant damping circuit includes a variable resistor.

10. An electrical signal translating circuit according to any one of Claims 1—9 for use in cascade with an amplifier circuit, in which the said predetermined frequency is the mid-frequency of the pass-band of the amplifier circuit.

11. An electrical signal translating circuit according to any one of Claims 1—10 for use in cascade with an amplifier circuit as an equaliser circuit, which may be adjusted to render the overall frequency/amplitude response of the two circuits connected in cascade substantially uniform over the pass-band of the amplifier circuit.

12. An electrical signal translating circuit according to Claim 11 for use in cascade with a high-frequency wide-band amplifier circuit.

13. An electrical signal translating circuit including an electrical signal translating circuit according to any one of Claims 1—12 as one or more stages.

14. An electrical signal translating circuit substantially as hereinbefore described with reference to any one of Figures 1, 3, 5 and 6 of the accompanying drawings.

For the Applicants,
W. J. C. CHAPPLE,
Chartered Patent Agent.

PROVISIONAL SPECIFICATION

Improvements in or relating to Electrical Signal Translating Circuits

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British company, and ROY FRANK PRIVETT, of Research Laboratories of The General Electric Company Limited, Wembley, Middlesex, a British subject, do hereby declare the nature of this invention to be as follows:—

The present invention relates to thermionic valve circuits.

It is frequently required to provide electrical circuits having a desired frequency/amplitude characteristic over a given frequency range. For this purpose it is known to use an additional circuit in cascade with such an electrical circuit in order to bring the overall frequency/amplitude characteristic to the desired form.

One example of the use of such a circuit is as a so-called "equaliser" in

cascade with an amplifying circuit which has a non-uniform frequency/amplitude characteristic over its working frequency range. The " equaliser " circuit is then designed to have a frequency/amplitude characteristic which will counteract this non-uniformity so that the overall characteristic of the circuits in cascade will be substantially uniform.

Where electrical circuits contain coupled resonant circuits tuned to a common frequency, the frequency/amplitude characteristic over the working frequency range instead of being substantially level over this range and falling away at lower and higher frequencies may instead be too peaked, that is it may fall away at lower and higher frequencies within the working range. Alternatively the characteristic may take the well known " double-humped " form. It is one object of the present invention to provide a thermionic valve circuit which will render more nearly uniform these particular forms of non-uniform frequency/amplitude characteristic.

According to the present invention a thermionic valve circuit comprises a first valve having a first parallel resonant circuit, resonant at a predetermined frequency, in the anode circuit thereof, which first resonant circuit is connected to a second parallel resonant circuit, also resonant substantially at said predetermined frequency, in the input circuit of a second valve, and a series resonant damping circuit resonant substantially at said predetermined frequency which is connected across part at least of one of the parallel resonant circuits, the arrangement being such that the effective value of a component of one or more of the resonant circuits can be varied to modify the frequency/amplitude characteristic of the circuit in a predetermined manner.

The effective value of a component may be varied by selectively coupling one or more further parallel resonant circuits directly in parallel with one of the parallel resonant circuits, the further parallel resonant circuit or circuits being also resonant at the predetermined frequency. Alternatively the effective value of the resistive component of the resonant damping circuit may be varied by selectively connecting one or more resistances in series with the damping circuit.

Two arrangements of thermionic valve circuits according to the present invention will now be described, by way of example, in which the circuits are adapted for use as " equalisers " in conjunction with wide-band high-frequency amplifying circuits.

The amplifying circuits form the intermediate frequency amplifiers of the final receivers at each terminal station of a television relay system. Both these intermediate frequency amplifiers and the intermediate frequency amplifiers at the relay stations are of the kind which include coupled resonant circuits tuned to a common frequency, and more particularly are of the kind described in the Provisional Specification of our co-pending Patent Application No. 30945/48. It is desired that the overall amplification for each of the amplifiers in the system should be substantially uniform over a bandwidth of 15 megacycles-per-second so that the bandwidth for the system including five amplifiers may be 9 megacycles-per-second, the coupled resonant circuits being resonant at approximately thirty-four megacycles-per-second. Thus the desired overall frequency/amplitude characteristic for all the amplifiers takes the form of a " flat-topped " curve. In practice, however, due to one or more of the circuits becoming misaligned, the characteristic curve may become too peaked or may take the well known " double-humped " form, and it is the function of the equaliser circuit to modify the overall frequency/amplitude characteristic so that the amplification is more nearly uniform over the selected bandwidth.

In the first arrangement the equaliser circuit consists of two high-frequency pentode valves whose cathode heaters and screen grids are connected to appropriate electric supplies, whilst the cathode leads to earth contain grid-bias resistances which are shunted by high-frequency by-pass capacitors in the normal manner. An inductance is connected between the anode of the first valve and, through a high-frequency decoupling circuit, the positive terminal of a high tension supply, the negative terminal of which is earthed. A second inductance is connected between the control grid of the second valve and earth, this control grid being connected through a direct-current blocking condenser to the anode of the first valve. A series resonant circuit consisting of an inductance, a capacitor and a resistance is connected between the anode of the first valve and earth, with one terminal of the resistance connected to earth. Two further resistances of different resistive values are each arranged to be individually switched in shunt with this resistance, so that the resistive component of the series resonant circuit may be reduced by switching-in either or both of these further resistances.

The value of the anode inductance is chosen so that together with the inter-electrode capacity between the anode and cathode of the first valve, and any other stray capacities to earth in parallel with the inductance, it forms a parallel resonant circuit which is resonant at thirty-four megacycles/sec. The value of the second inductance is likewise chosen to form a parallel resonant circuit with the inter-electrode and stray capacities between the control grid and cathode of the second valve, which circuit is resonant at the same frequency. The series resonant circuit is also arranged to be resonant at this frequency. There are four possible values for the resistance of the series resonant circuit, namely with neither of the further resistances in circuit, with only one of the further resistances in circuit, with only the other in circuit and with both of the further resistances in circuit. The form of the frequency/amplitude curve for the equaliser circuit alone will depend upon the damping effect of the series resonant circuit at frequencies close to the predetermined frequency, and the values of the resistances are chosen so that with the four possible different values of resistance the frequency/amplitude curve for the equaliser circuit may be substantially flat over the desired bandwidth, may be too peaked, or may be "double-humped," as required, according to the resistance switched into the circuit.

In operation the output from the intermediate frequency amplifier is connected to the input of the equaliser circuit and the output of the equaliser circuit is applied to the final demodulator stage. If the overall frequency/amplitude characteristic up to the input of the equaliser circuit gives a peaked curve, then the appropriate resistances will be included in the series resonant circuit so that the characteristic curve for the equaliser circuit is of "double-humped" form, which will tend to render more nearly flat the overall or combined characteristic up to the output of the equaliser. In the same way if the characteristic curve up to the input to the equaliser is "double-humped," the equaliser will be adjusted so that the characteristic curve of the equaliser alone is peaked. It will be understood that the greater the number of the resistances which are used the more nearly can the equaliser circuit be adjusted to reduce the forms of non-uniformity under consideration. The series resonant circuit may alternatively be connected between the control grid of the second valve and earth.

This first arrangment suffers from the possible disadvantage that the gain of the equaliser at frequencies adjacent to the resonant frequency varies with variations in the resistive value of the series resonant circuit. The second arrangement does not however suffer from this disadvantage.

In the second arrangement of the equaliser circuit, the circuit is similar to the first arrangement, but the further resistances in the series resonant circuit are excluded and instead a pair of further parallel resonant circuits are provided which are each arranged to be independently connected in parallel with the inductance in the input circuit of the second valve. Each of the further parallel resonant circuits are arranged to be resonant at the same frequency as the other resonant circuits in the equaliser, but are chosen to have different values for the same type of reactance in the two circuits. By switching in either or both of the further resonant circuits, the characteristic curve of the equaliser is varied so that by a suitable choice of values the equaliser circuit can be used in a similar manner to the first arrangement, but without appreciable variations in the gain adjacent to the resonant frequency. As before, the compensation may be made more exact by the provision of a larger number of circuits by which the compensation is effected.

It is to be understood that circuits according to the present invention are only adapted for reducing non-uniformity in the frequency/amplitude characteristic of the "peaked" or "double-humped" form. They are not adapted to correct "tilt" in the characteristic, that is when the amplitude increases or decreases linearly with frequency over the desired bandwidth, for which purpose a circuit according to the invention described in the Provisional Specification of our co-pending Patent Application No. 10628/49 (Serial No. 675,562) may be used. The equaliser circuit may, of course, be both in accordance with the present invention and in accordance with the invention described in the aforesaid application, in which case the equaliser circuit will preferably comprise the second of the above described arrangements.

Where the equaliser circuit and the amplifier circuit are of a similar nature, for example they both utilize coupled circuits of a similar type, the equaliser circuit will also serve to correct any variations in the phase/frequency characteristic of the amplifier which may arise due to the amplifier circuits becoming misaligned.

It will be appreciated that the inven-

tion is not limited to use with intermediate frequency amplifiers nor to radio equipment, but may be used for example in line telecommunications equipment. Moreover, although in the arrangements described above the circuit according to the invention has been separate from the apparatus whose characteristic it is adapted to modify, the circuit may form an integral part of such apparatus. Thus it may be one of the stages, and not necessarily the last stage, of an amplifier.

Dated the 21st day of April, 1949.

For the Applicants,
W. J. C. CHAPPLE,
Chartered Patent Agent.

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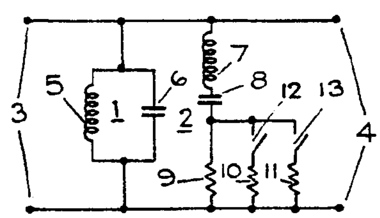

FIG. 1

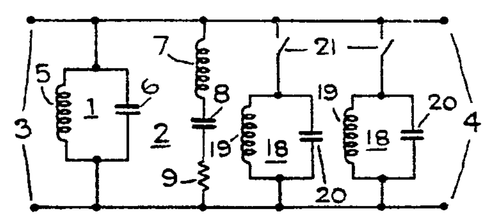

FIG. 3

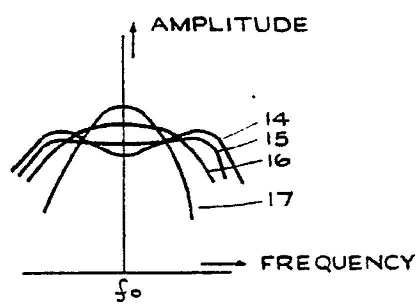

FIG. 2

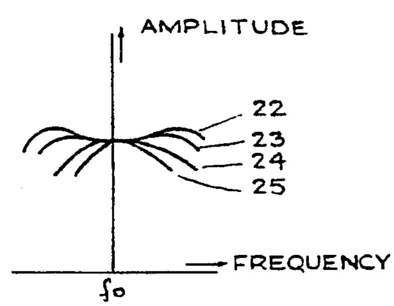

FIG. 4

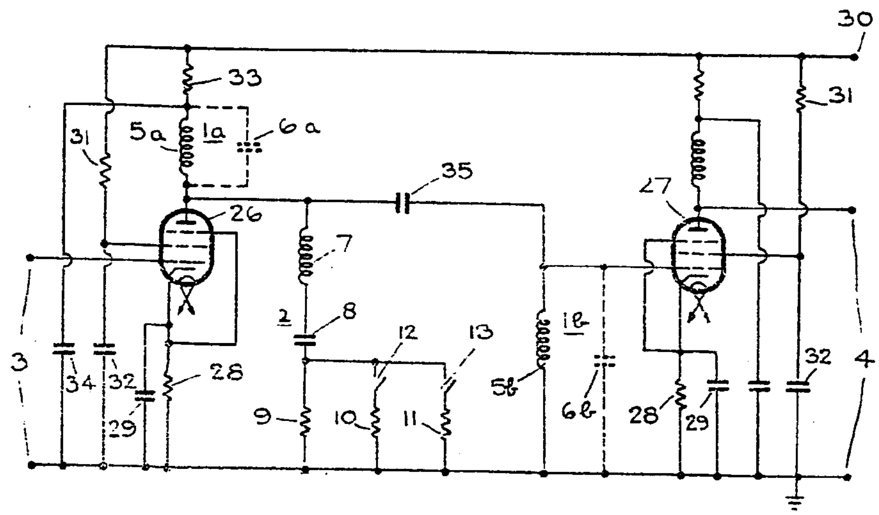

FIG. 5

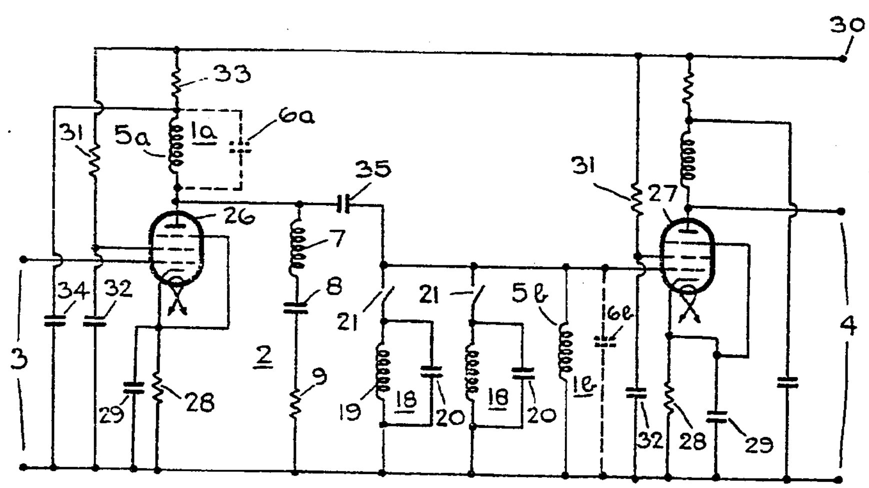

FIG. 6

1020 - M.M.P. LTD - 1952

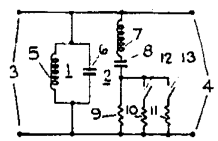

FIG. 1

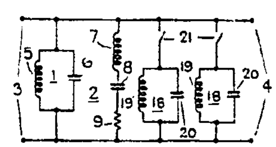

FIG. 3

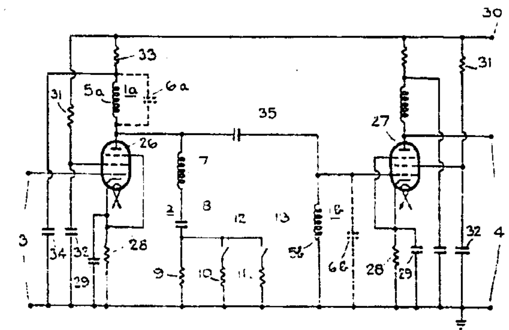

FIG. 5

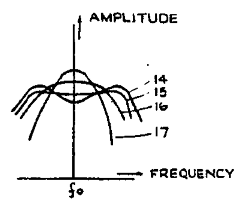

FIG. 2

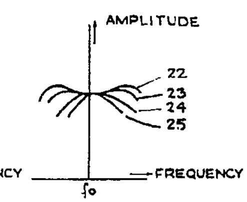

FIG. 4

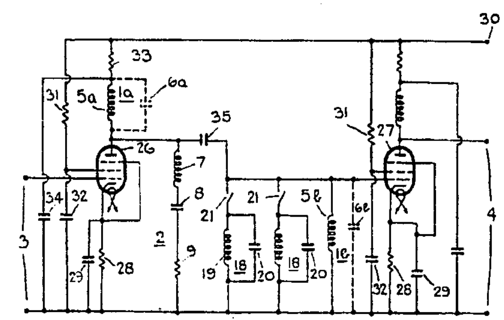

FIG. 6

1020 - M M P L^TD - 1952